

PPT Program

Past



*Roland Berry Ann
Deputy Director, NPPTL*

Present



Future



Courtesy of: Viramask

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PPT Program Coordinator*

Respiratory Protection – Not New

Pliny the Elder (23-79) described a filtering device for use against vermillion dust



16th century-16th Century –
Leonardo da Vinci envisioned a cloth mask used to protect a person from toxic powder

- The history of protective masks dates back to the 16th century.
- Leonardo da Vinci (1452-1519) described a fine cloth dipped in water to cover the nose and mouth.
- The description indicates that the mask could protect sailors from a toxic powder weapon he had designed.

Sources:

<http://www.womensmemorial.org/H&C/Collections/photoexample.html>

<http://www.kausal.com/leonardo/>

Respiratory Protection – Not New to Healthcare

17th Century Physician
Visiting a Plague House



21st Century Surgeons in a Modern
Operating Room



First U.S. patent for an air-purifying respirator granted in 1849

- **Haslett's Lung Protector used a moistened wool filter or similar porous material and two one-way clapper valves to filter dust.**
- **One valve allowed inhalation of air through the filter**
- **One valve released exhaled air into the atmosphere.**

Congress established the U.S. Bureau of Mines in 1910

- Prior to USBOM, coal mine fatalities exceeded 2000 annually
- Charged to adopt improved safety procedures to help reduce accidents in the coal mining industry



During the 1918 Pandemic face coverings were used by the general public for protection



1918 – Facemasks used to protect against influenza





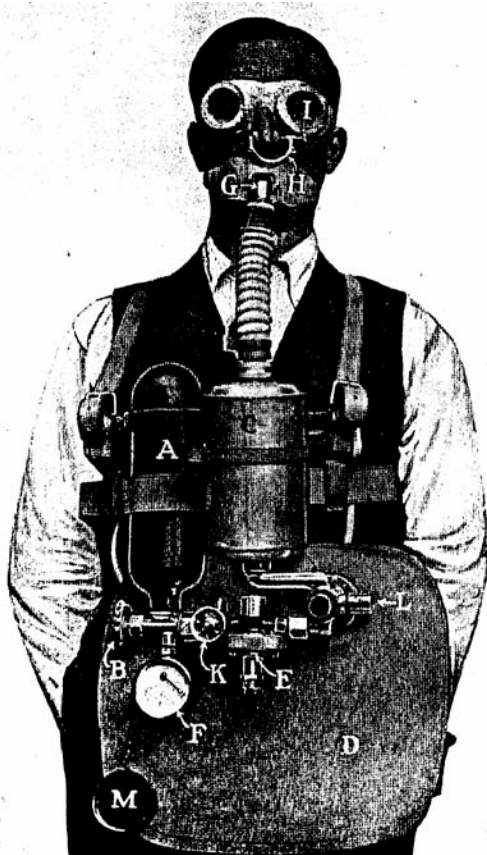
During the 1940s, overseas, military personnel, nurses and civilians were legally required to carry gas masks at all times.

Source: <http://www.womensmemorial.org/H&C/Collections/photoexample.html>



Harriette (Burandt) York Collection, Gift of Marylouise Ethington, Women's Memorial Foundation Collection.

Advancements in Protection



1917 MSA



1917 MSA



1924 BOM
Kilman's
cap-style
dust respirator

Early PPT Activities, Including the Creation of NIOSH (Pre-1977)

- The first concerted effort to address the safety and protection of coal miners was the creation of the USBM in 1910.

1910

Bureau of Mines created



1969

Mine Act mandates joint DOI/HEW approval of respirators

- When NIOSH was established in 1971, a crucial need to determine the correct role of respiratory protection in workplaces was recognized.

1970

OSH Act creates NIOSH

1972

NIOSH and BOM consolidate Approval Schedules into regulations

PPT Program (1977-1996)

- In 1977, the NIOSH Division of Safety Research (DSR) was created in Morgantown, West Virginia, becoming the first division-level focus on PPT research within NIOSH. DSR work included the testing and certification of respirators and other PPE.
 - Prior to 1995, all respirator certifications were issued jointly by MSHA and NIOSH. Under the new respirator certification regulations (42 CFR Part 84), NIOSH became the sole approving authority for most respirators.
- 1977** PPT research established in NIOSH's DSR
- 
- 1995** NIOSH publishes 42 CFR Part 84 approval requirements

Resurgence of *Mycobacterium tuberculosis* (Mtb) (1990 – 1994)

- **Modes of Transmission Debates**
- **Respiratory Protection Level Debates**
 - Surgical Mask – High Efficiency PAPR
 - Comfortable protection
 - Cost effective
 - Fit testing issues
- **Healthcare Support for New N95 Respirator**

1995-Federal Regulation 42 CFR Part 84

- Certification requirements for respiratory protective devices upgrades testing requirements for particulate filters.
- New public health regulations replace MSHA regulations



Proposal for Federal Certification of PPE and Clothing for Firefighters and Emergency Response Personnel

- Report prepared by NIOSH and contractor in response to 1997 Senate Appropriations Report Number 104-368, DOL, DHHS, Education and Related Agencies Appropriations Bill, HR 3755

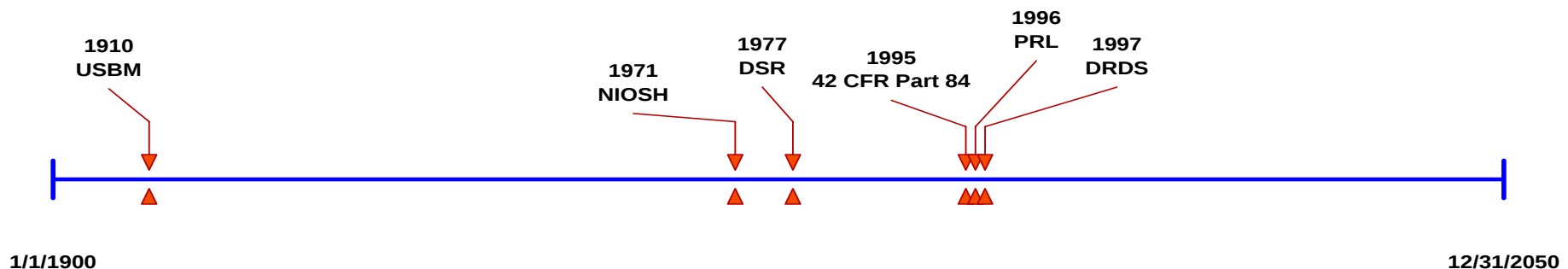
The Committee is aware of concern over the lack of standards and certification of personal protective clothing and equipment used by firefighters and emergency response personnel.

- Submitted to NIOSH Director in 1997 in preparation for 1998 budget hearings.
- No action taken

PPT Program (1997-2000)

Two significant events occurred during 1996-1997 that had major impacts upon the PPT Program:

- First, the USBM was abolished, resulting in the transfer of the Pittsburgh Research Laboratory (PRL) into NIOSH, together with its hearing protection activities.
- Second, NIOSH's respirator certification functions were transferred from DSR to the Division of Respiratory Disease Studies (DRDS).



Evolution of NIOSH Respirator Regulations

1910	Bureau of Mines created
1919	BOM publishes Schedules 13 and 14
1969	Mine Act creates MESA from BOM, mandates joint DOI/HEW approval of respirators
1970	OSH Act creates NIOSH
1972	NIOSH and BOM consolidate Approval Schedules into regulations
1973	BOM approval responsibility transferred to MESA
1977	Mine Act transfers MESA to DOL as MSHA, mandates joint DOL/HEW approval of respirators
1995	NIOSH publishes 42 CFR Part 84 approval requirements
2001	NPPTL created with respirator program as cornerstone

NPPTL Congressional Direction

- **Congressional FY 2001 Appropriations Bill:**
 - Identified the need for protective equipment
 - Encouraged research for personal protective technologies
- **Congress allocated funds to establish NPPTL**



Foundation of NPPTL

Morgantown

Respirator
Approval
Program

Protective
Clothing

Respirator
Research

Policy &
Standards
Development

Pittsburgh

Long-Term
Field
Evaluation

New

NPPTL
Research
Focus Areas

NPPTL

The terrorist attacks of 9-11 intensify the need for CBRN respirator standards

- Large numbers of respirators anticipated in time of large-scale response
- Decontamination procedures needed for safe removal and disposal of respirators



Severe Acute Respiratory Syndrome (SARS) 2003

- SARS global outbreak of 2003 spread to more than two dozen countries in North America, South America, Europe, and Asia in a few months before it was contained.
- Respirator supply issues
 - Extended use
 - Combination of protections



NIOSH PPT Program Relevance and Impact

Mine Escape Issues

- Mine Emergency Respirator Investigations
- New Technology Research
- Escape Respirator Research
- Escape Respirator Standards
- MSHA Collaboration

CBRN Issues

- Respirator Standards Development
- CBRN PPT Research
- Respirator Certification
- NFPA/IAFF Collaboration
- TSWG IAA
- OSHA Collaboration



Nanotechnology Issues

- Filtration Research
- Protective Clothing Research
- Respirator Research
- Respirator Certification
- Workplace Guidance

Pandemic Issues

- N95 Respirator Research
- Standards (Total Inward Leakage)
- Respirator Certification
- FDA Collaboration
- National Academies Activities
- Pandemic Planning and Response



NIOSH Program Portfolio Structure

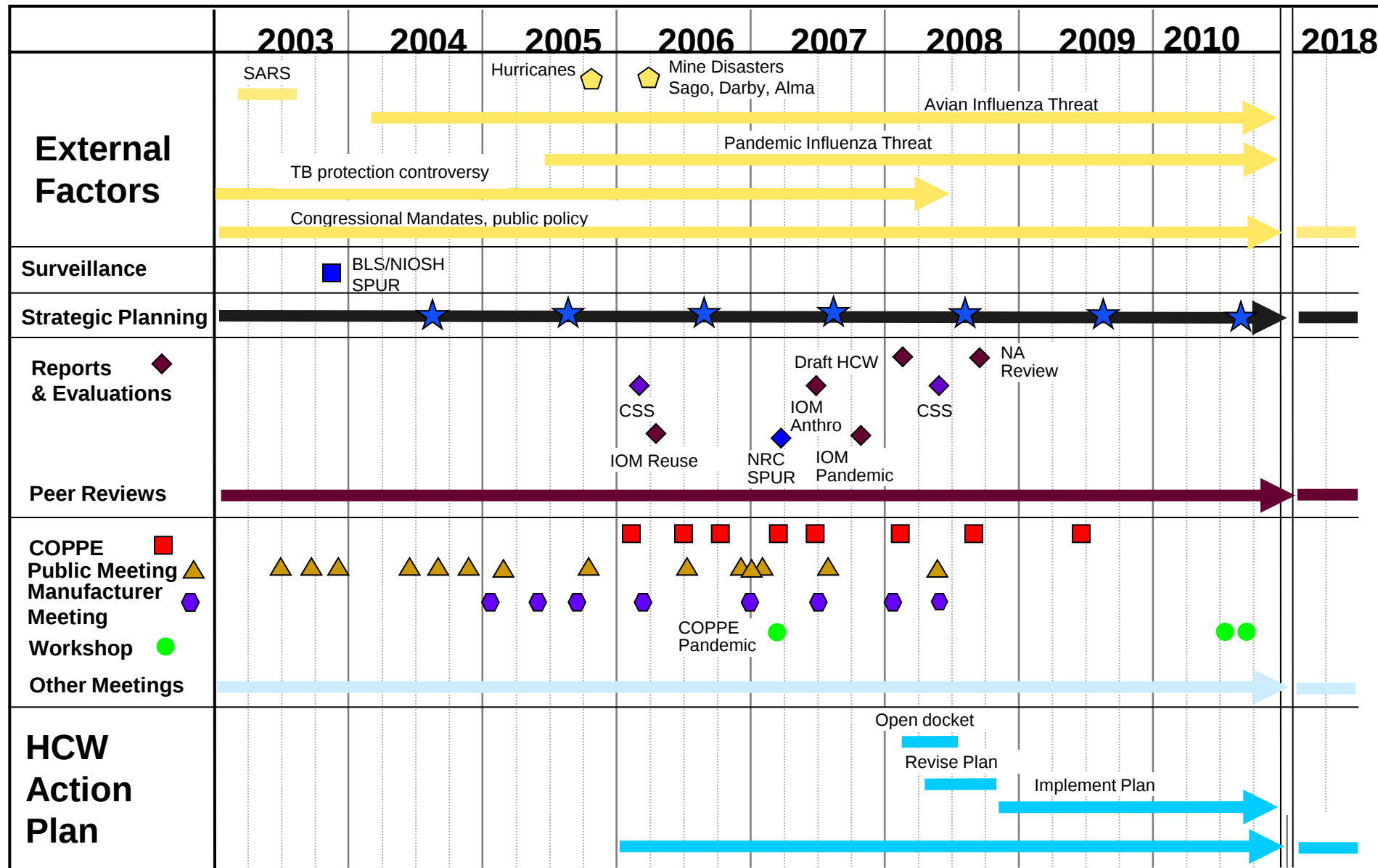
Established in 2006

NORA / NIOSH Industry Sectors (N=8)	NIOSH Cross Sector Programs (N=24)
• Agriculture, forestry, and fishing • Construction • Healthcare and social assistance • Mining – Oil & Gas Extraction • Manufacturing • Services – Public Safety • Transportation, warehousing, and utilities • Wholesale and retail trade	• Authoritative recommendations development • Cancer, reproductive, cardiovascular, neurological & renal diseases • Communications and information dissemination • Emergency preparedness/response • Global collaborations • Health hazard evaluation (HHE) • Hearing loss prevention • Immune, dermal and infectious diseases • Musculoskeletal disorders • Personal Protective Technology (PPT) • Radiation dose deconstruction • Respiratory diseases • Training grants • Traumatic injury • Work organization and stress-related disorders • Economics • Exposure assessment • Engineering controls • Work life initiative • Occupational health disparities • Small business assistance and outreach • Surveillance • Nanotechnology • Prevention through design

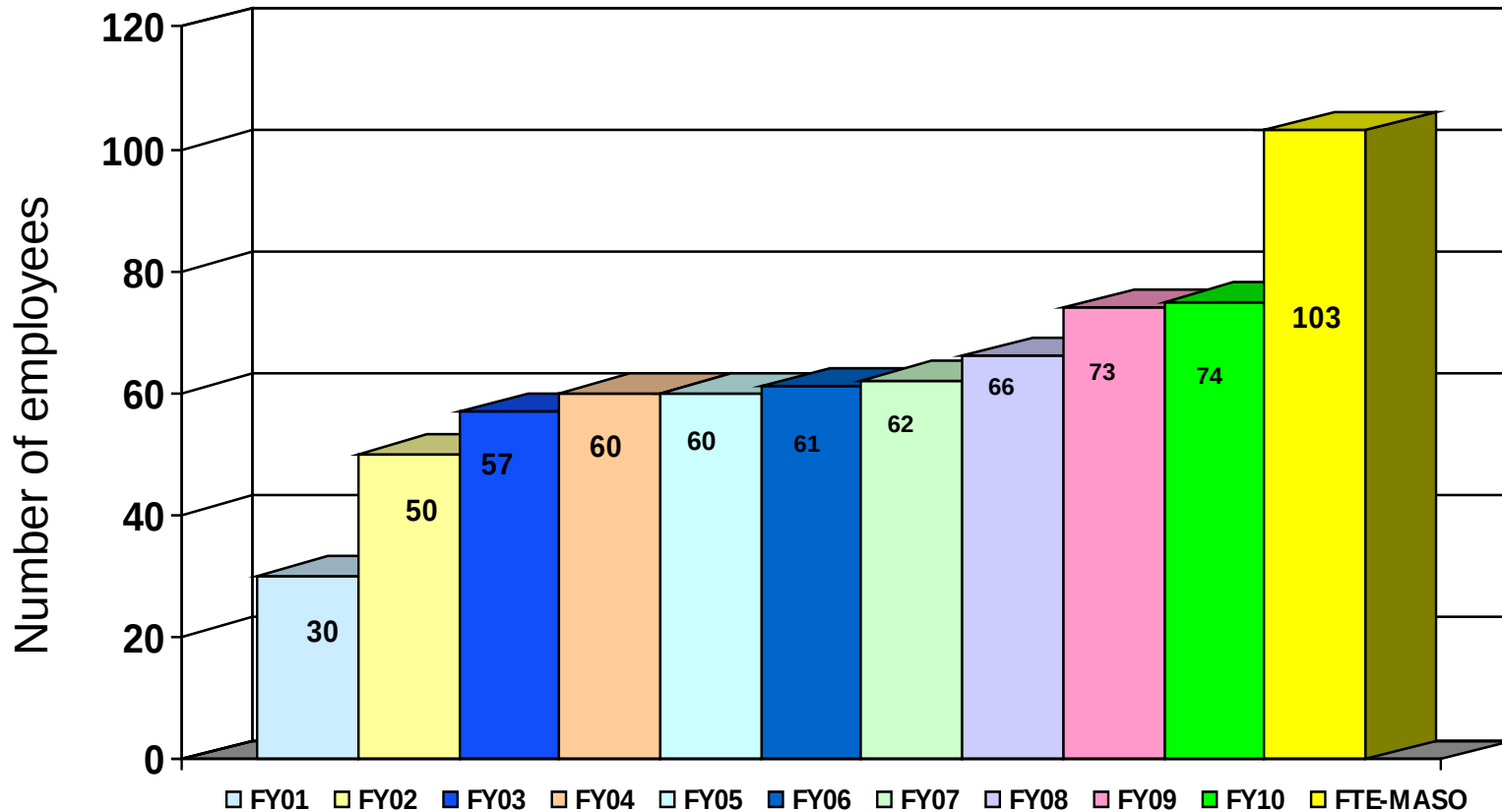
Where are we going?



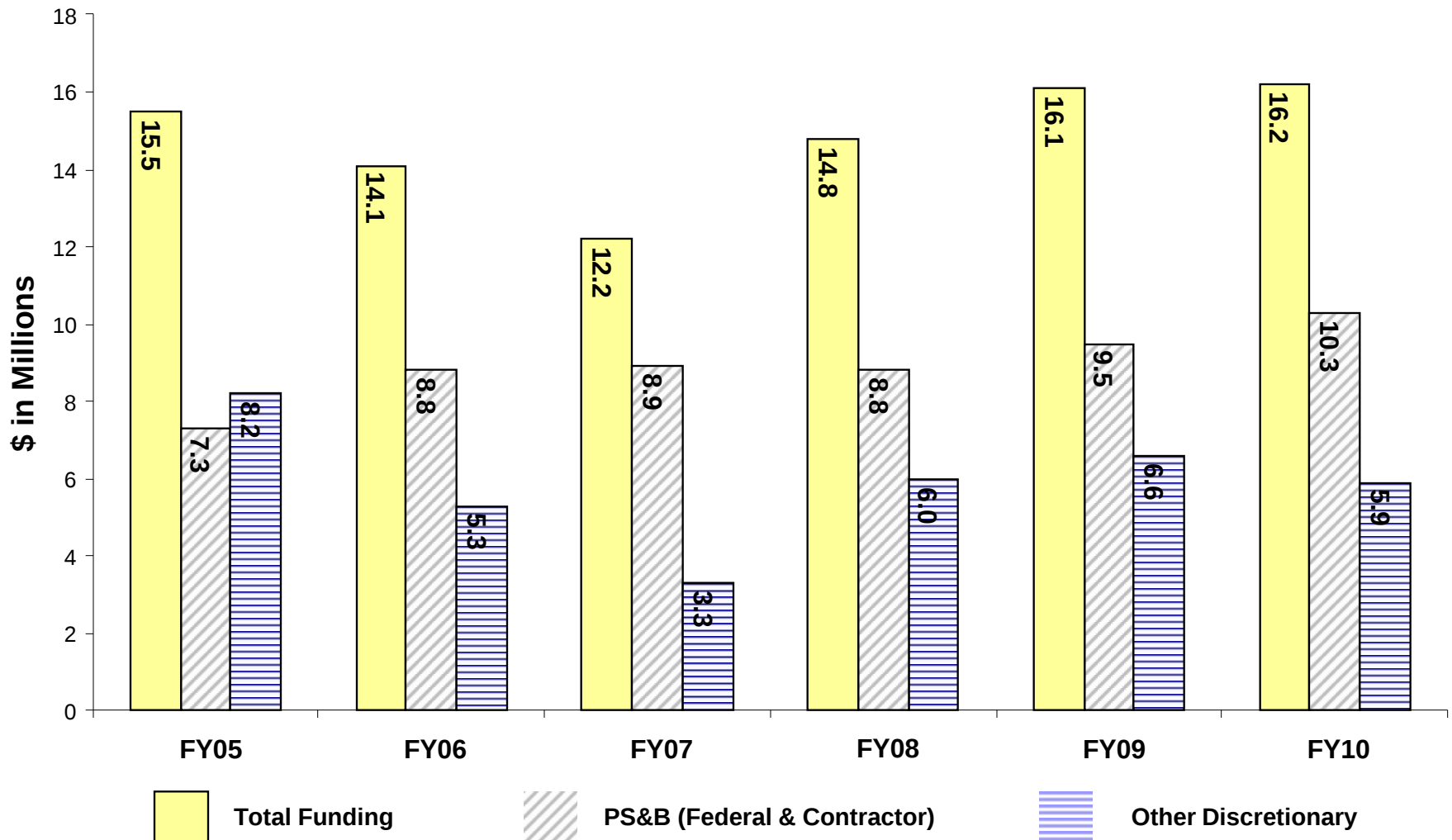
PPT Program Planning Inputs Drive the Future



The PPT Program Target is 103 employees



PPT Program has received modest funding increases



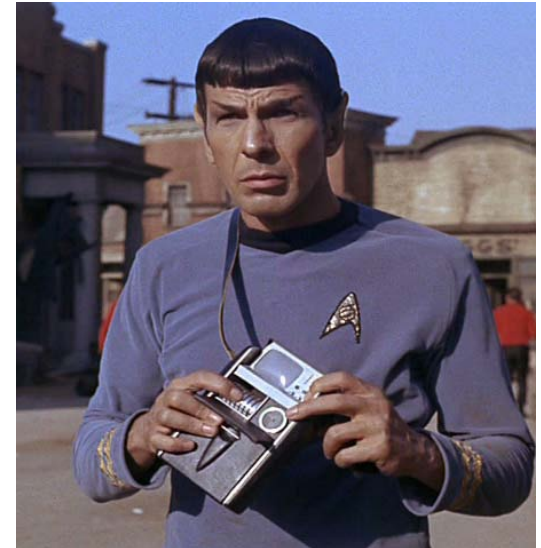
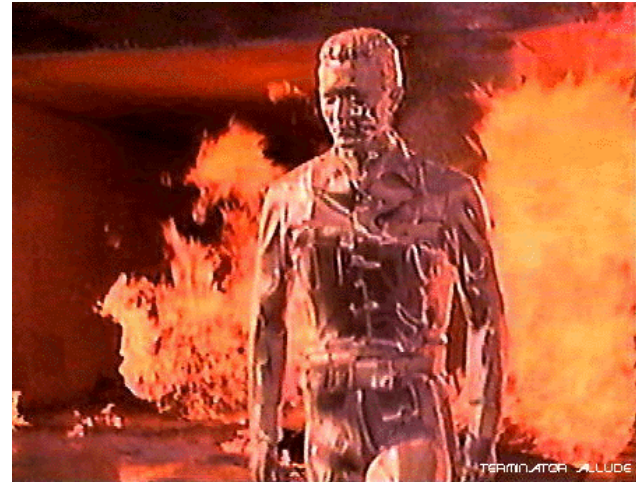
National Academies' PPT Program Evaluation Discussed Emerging Issues

- Continue research in priority areas
- New materials technology, including “no-fit” respirators
- PPT ensembles and seamless integration of multiple PPT components
- Usability, comfort, ergonomics, and human factors which determine whether or not the PPE is worn by the worker
- Enhancing the culture of workplace safety through worker education, training, and understanding of hazardous exposure risk to health
- Other emerging issues

Some Trends and Challenges

- **PPE interfaces and integration**
- **Certification of non-respiratory PPE**
- **Comfort and fit of PPE**
- **Intelligent PPE**
- **Methods to extend the useful life of PPE**

How can nature and science fiction be leveraged for future PPE designs?



PPE ensemble integration is a challenge

- **Need to demonstrate that PPE works together**
- **Need to understand the impact on the NIOSH approval when respirators are used as part of an ensemble**
- **Need to know what interface parameters affect performance**

Certification of non-respiratory PPE is being explored

- **NA Recommendation:** *“Oversee all PPT certification in order to ensure a minimum uniform standard of protection and wearability”*
- **PPT Program incorporated non-respiratory certification in Action Plan**
- **PPT Program funded the IOM to explore:**
 - How can NIOSH oversee certification of all PPT as stated by the NA Evaluation of the PPT Program to “oversee all PPT certification in order to ensure a minimum uniform standard of protection and wearability”?

from The PPT Program at NIOSH: Review of Research Programs of NIOSH, IOM and NRC (2008), page 12

- **ASTM created new subcommittee on Certification and PPE Interoperability (F23.50)**

Seamless interfaces between PPE components will be developed

- Respirators and other PPE
- Improved communications
- Ability to interoperate with or function when using other required devices (e.g. stethoscope)



Human centered design approaches are needed

- Design with personality and behaviors in mind
- Reduce weight
- Reduce heat stress
- Improve usability and safety



Issues with comfort and fit

- **Users in multiple industry sectors indicate that PPE is not worn because it is uncomfortable**
- **There is a resistance to respirator fit testing across multiple industry sectors**
- **Sizing for population diversity is problematic**

New materials technologies will enhance comfort and fit

- **Shape memory polymers**
 - Potential means to achieve improved comfort and fit
 - More breathable garment material
- **New no-fit test designs being explored**



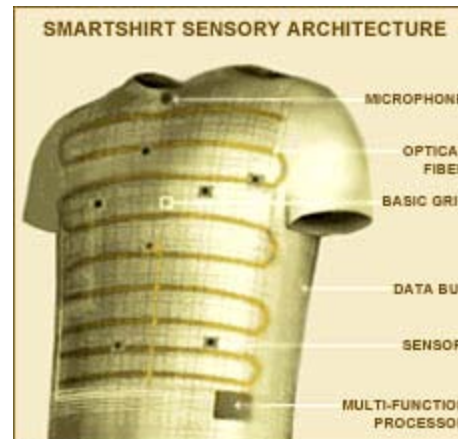
Courtesy of:
Viramask

Geckos have microscopic hair-like surfaces on their feet



Sensing technology for PPE is in its infancy

- Current projects focused on end-of-service-life technology
- Numerous sensing technologies developed
 - Tracking sensors
 - Monitoring sensors
 - Warning sensors



Intelligent PPE will be developed to inform users when PPE is no longer efficacious

- End-of-service life
- Remaining service life
- Face-seal leak detection will warn users when seal is compromised

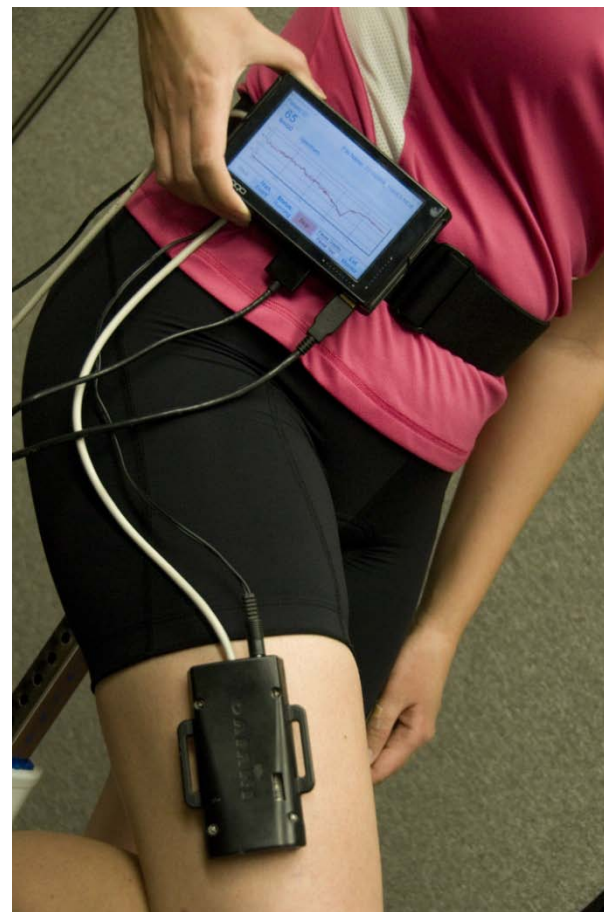


Yesterday's science fiction...

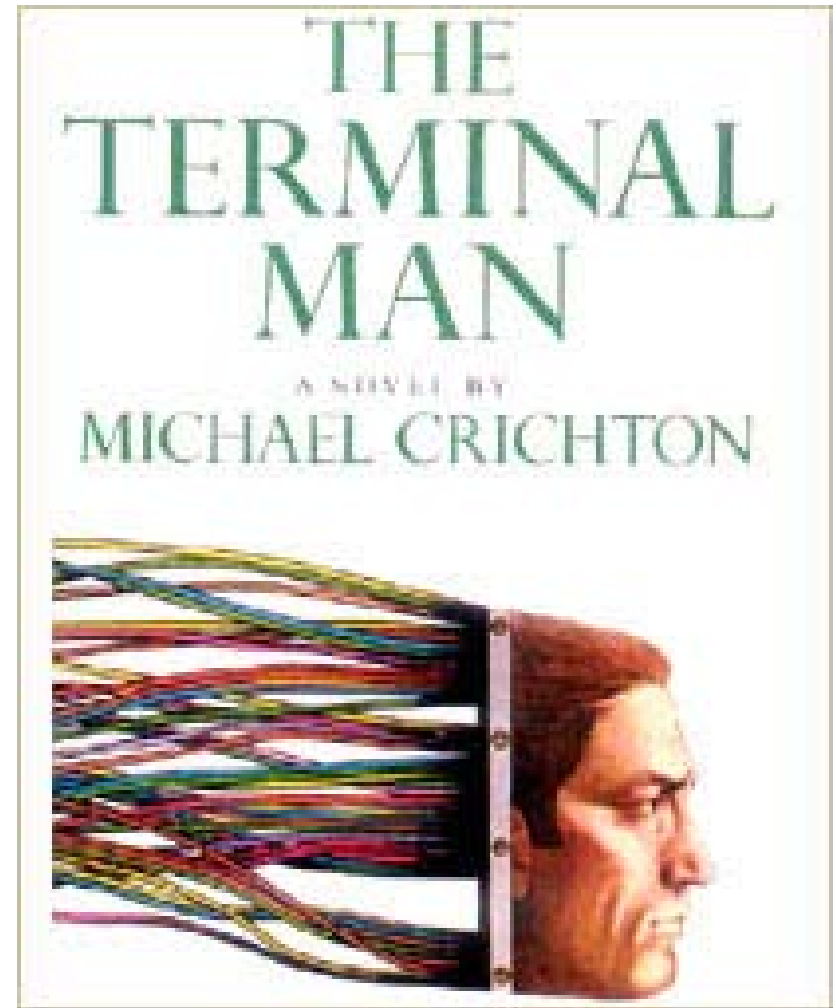


Is tomorrow's science...

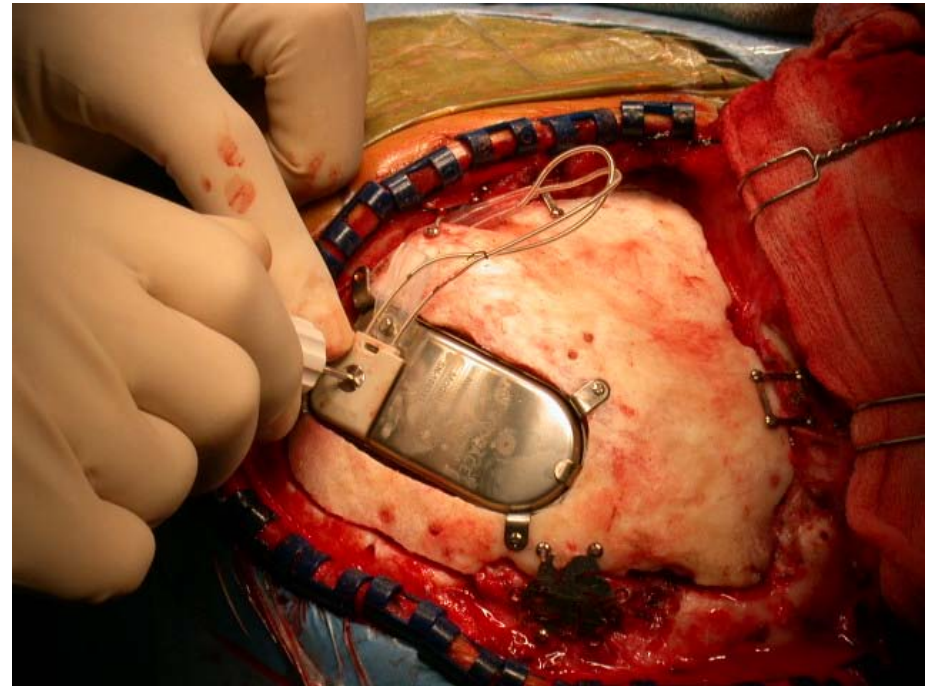
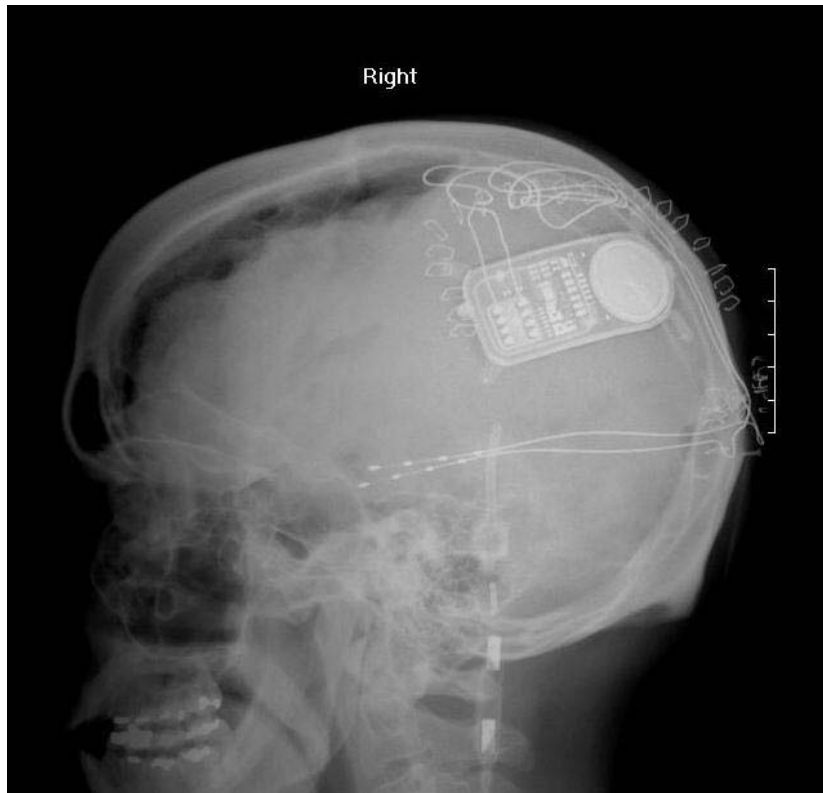
- Noninvasively measures oxygen consumption, blood and tissue chemistry
- Let's astronauts know when they are low on oxygen



In 1972, Michael Crichton imagined a brain implantable device to terminate seizures



Today, clinical trials are underway to terminate seizures with a brain implantable device

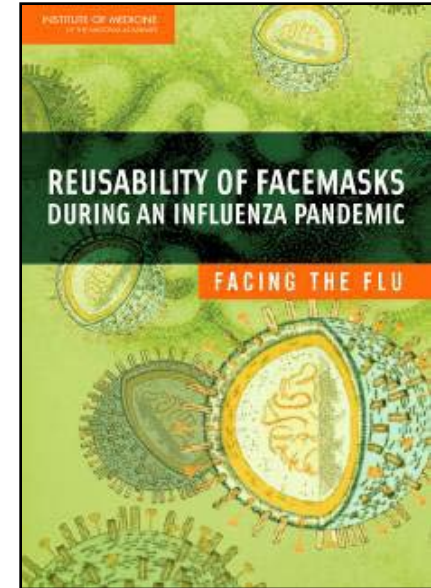


CAUTION-Investigational device. Limited by United States law to investigational use.

Used with permission from Neuropace Inc.

Methods to extend the useful life of PPE are needed

- 90 million FFRs needed to support 42 day pandemic outbreak
- 1.7 million healthcare-associated infections annually
- Cause about 99,000 deaths
- Cost from \$35.7 to \$45 billion in additional healthcare costs annually
- \$15,000 per incidence
- PPE may survive on FFRs long enough to present a fomite hazard



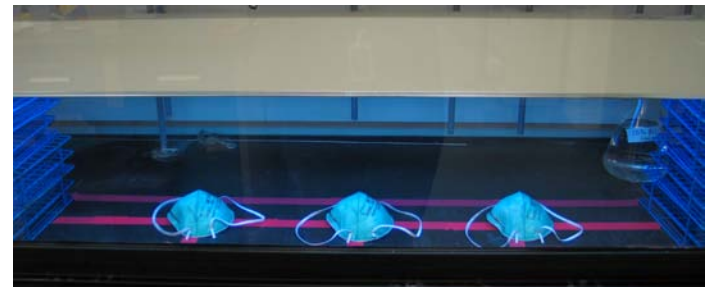
Methods to extend the useful life of PPE have been explored

- Some decontamination methods have been successful on FFRs
- Decontamination procedure is device dependent
- Manufacturers should identify most appropriate procedure for their technology

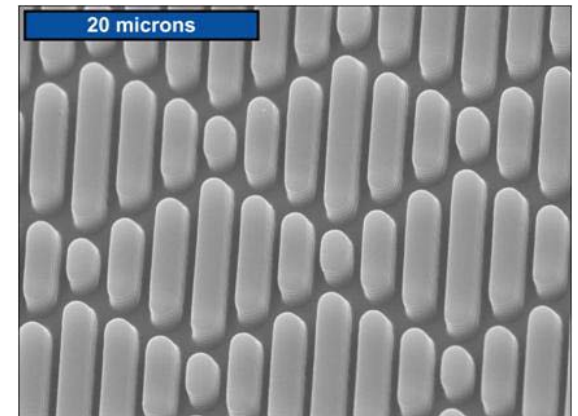
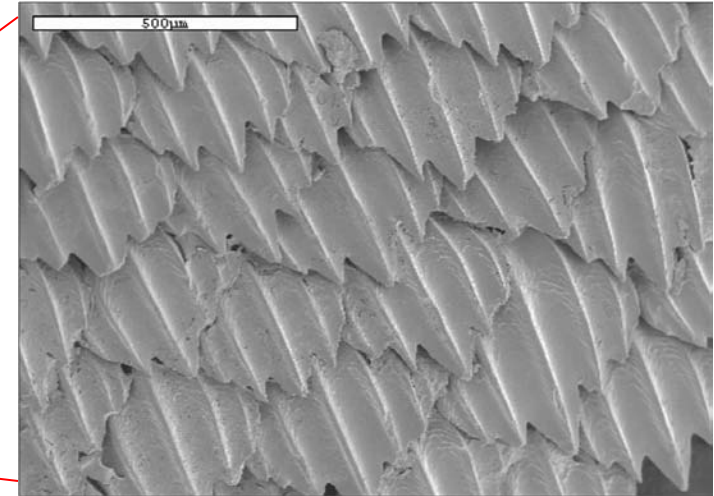
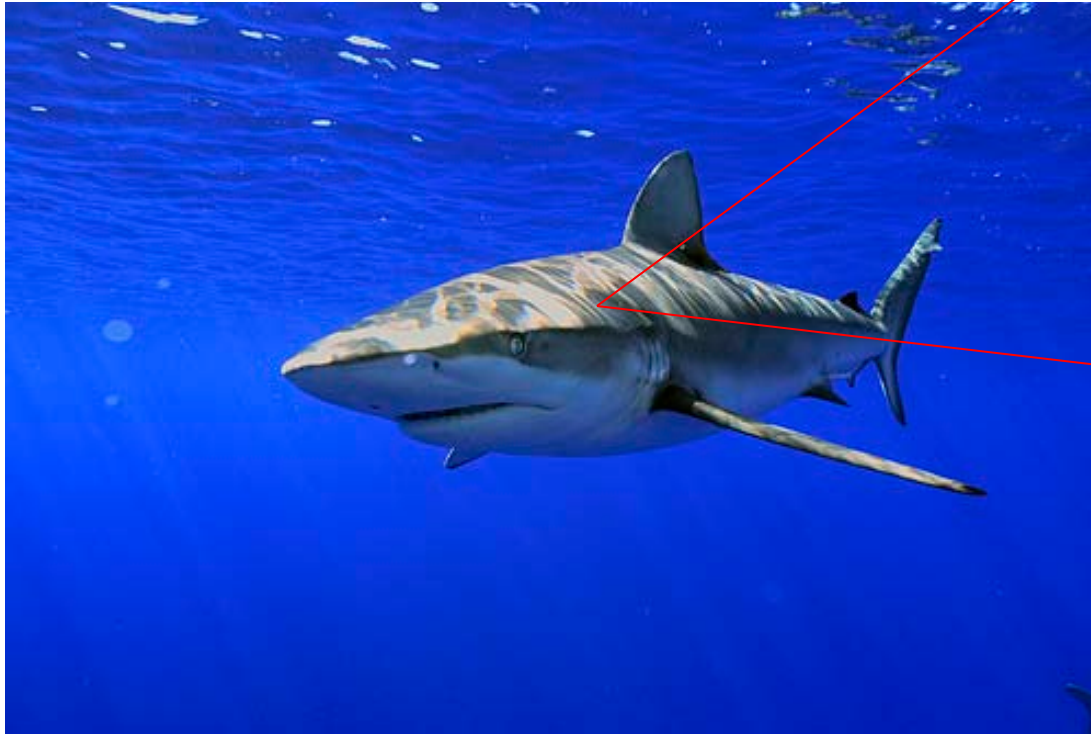
Microwave Generated Steam



Ultraviolet-C Irradiation



Unique surface pattern of Galapagos shark skin controls microorganism adhesion and growth



Superhydrophobicity causes water to bead and pick up surface contaminants



Superhydrophobic legs enable mosquitoes and water striders to stand on water surfaces



Geckos rely on their tails to maneuver themselves in midair when they fall



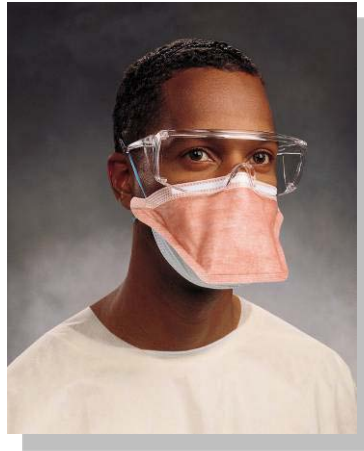


Can all PPE be made as comfortable, efficient, and effective to wear and as desirable as eyeglasses?

The future is now....



NIOSH PPT Program



Visit Us at: <http://www.cdc.gov/niosh/programs/ppt/>

<http://www.cdc.gov/niosh/npptl/default.html>

Thank you